Early Numeracy: Response to Intervention: Tier 2 Intervention

Council for Exceptional Children

4/3/09

Diane P. Bryant, Brian R. Bryant,

Jennifer Porterfield, Kathleen Hughes

The University of Texas at Austin

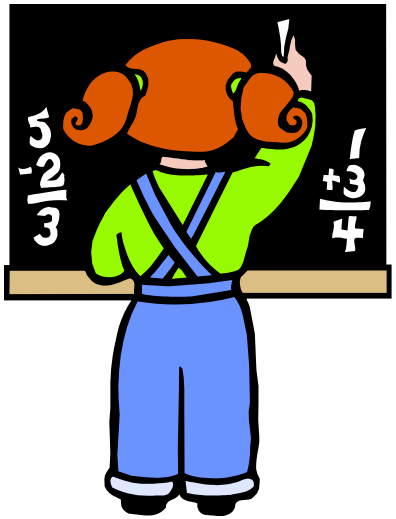
Department of Special Education

Meadows Center for Preventing Educational Risk:

Mathematics Institute for Learning Disabilities and Difficulties

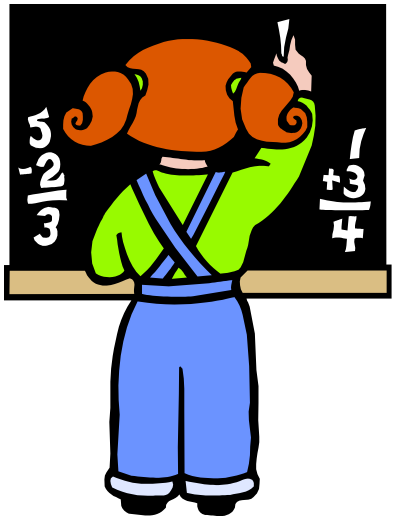
Supported in part by a grant # R324B070164 from the U.S. Department of Education, Institute of Education Sciences. No official endorsement should be inferred.

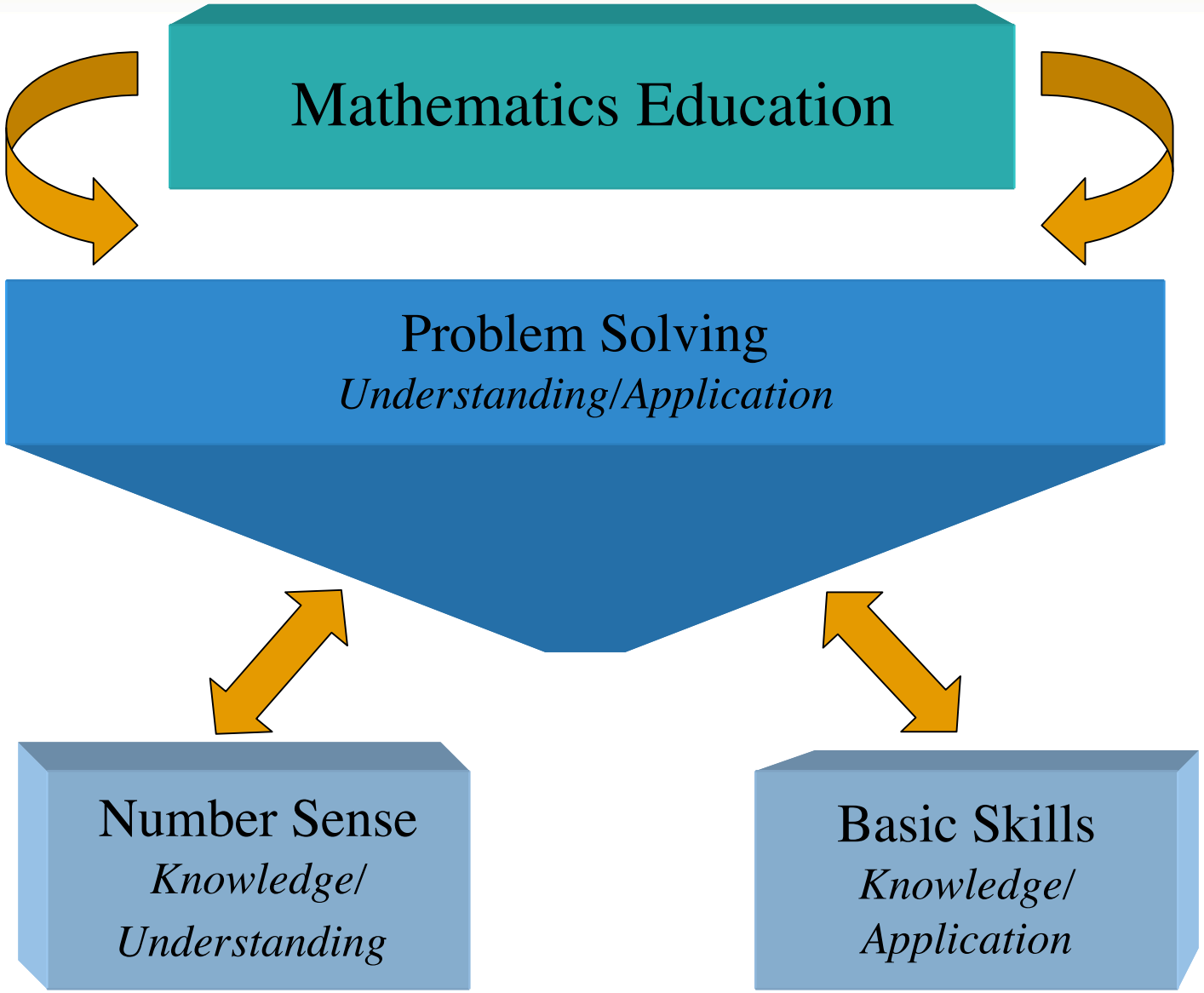
Advance Organizer



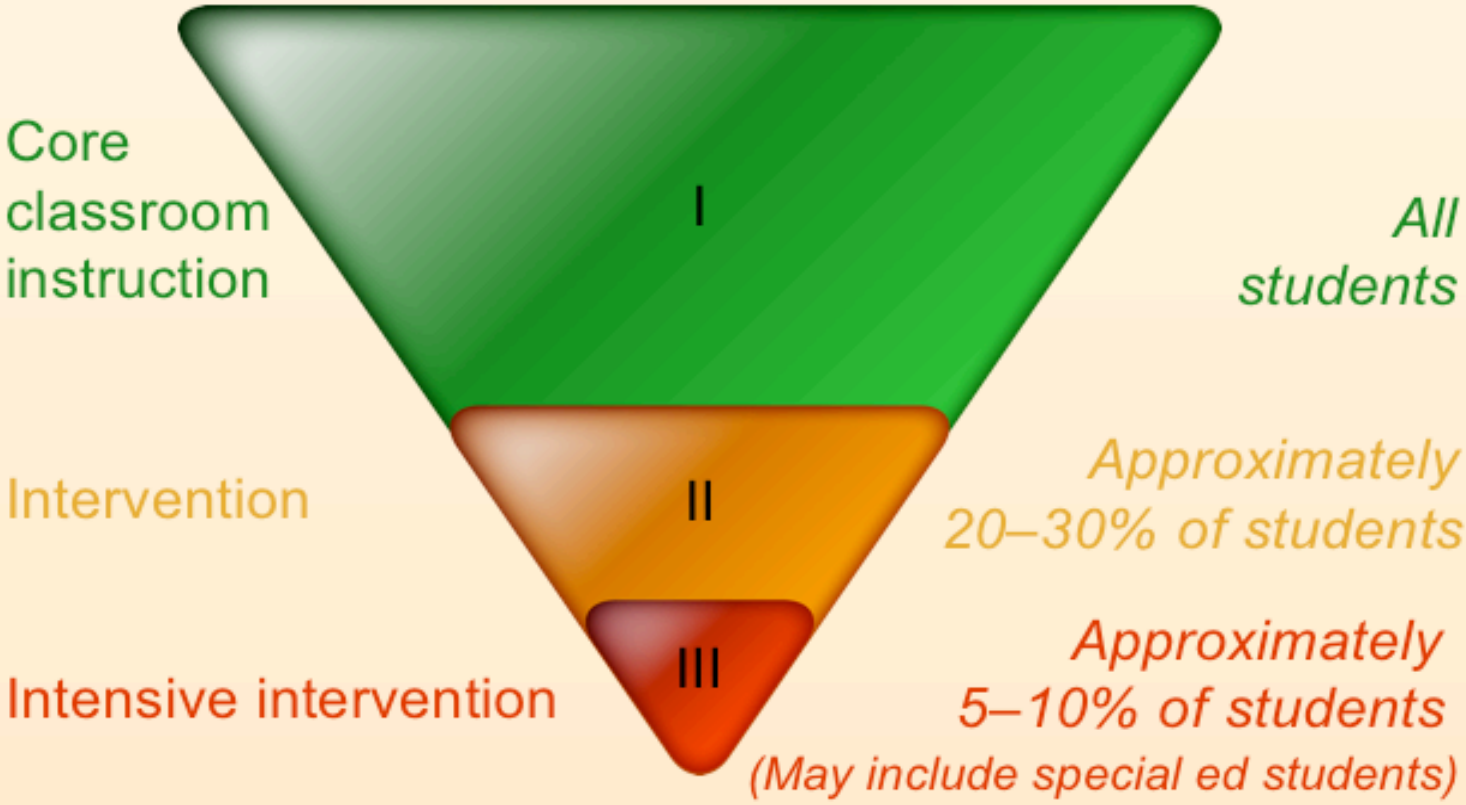
- Mathematics Education and a 3-Tier Model
- Assessment & Progress Monitoring
- Tier 2 Intervention Booster Lessons

Mathematics Education and a 3-Tier Model




Mathematics Education
Problem Solving
Understanding/Application
Number Sense
Knowledge/
Understanding
Basic Skills
Knowledge/
Application

A 3-Tier Intervention Model



NCTM *Curriculum Focal Points & Connections*, Sept. 2006

http://www.nctm.org/focalpoints/downloads.asp

Kindergarten:

Number & Operations: Representing, comparing, and ordering whole numbers and joining and separating sets (Geometry, Measurement)

First Grade:

Number & Operations & Algebra: Developing understanding of addition & subtraction and strategies for basic addition facts and related subtraction facts

Number & Operations: Developing an understanding of whole number relationships including grouping in tens & ones (Geometry)

Second Grade:

Number & Operations: Developing an understanding of the base-ten numeration system and place-value concepts

Number & Operations & Algebra: Developing quick recall of addition facts and related subtraction facts & fluency with multidigit addition and subtraction (Measurement)

What does it take . . . . .

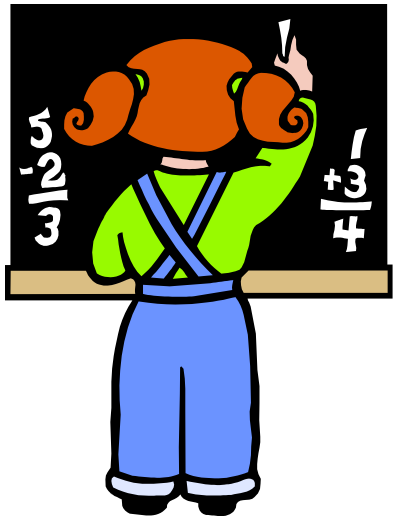
- To use the count-on strategy to add 9+3=?
- To use the doubles +1 strategy?
- To identify where to put the number 50 on a number line?
- To use a hundreds chart to count by 10s beginning with 32?
- To use the decomposition strategy to add 9+4=?
- To identify which number is greater: 49 or 62?
- To tell which number comes before 21?
- To subtract two numbers that require regrouping?

Early Predictors of Math Achievement*

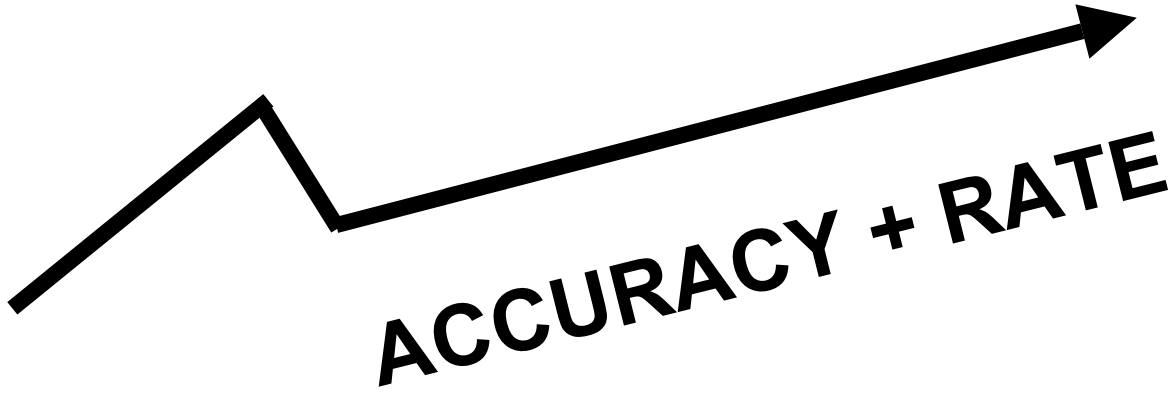
Task	Areas Assessed
Counting skills	Set enumeration; rote counting; 1-1 correspondence; stable order; cardinality
Number knowledge	Relationships between numbers (e.g., magnitude comparisons)
Nonverbal calculation:	
Set transformations under a box	Adding or taking away objects hidden ("How many objects under the box?").
Story problems	Single-digit addition and subtraction problems embedded in stories
Number combo	Single-digit addition and subtraction problems ("How much is 2 + 1?)

*From: Jordan, N.C. (2007). Do words count? Compilation of results from several studies.

Assessment & Progress Monitoring

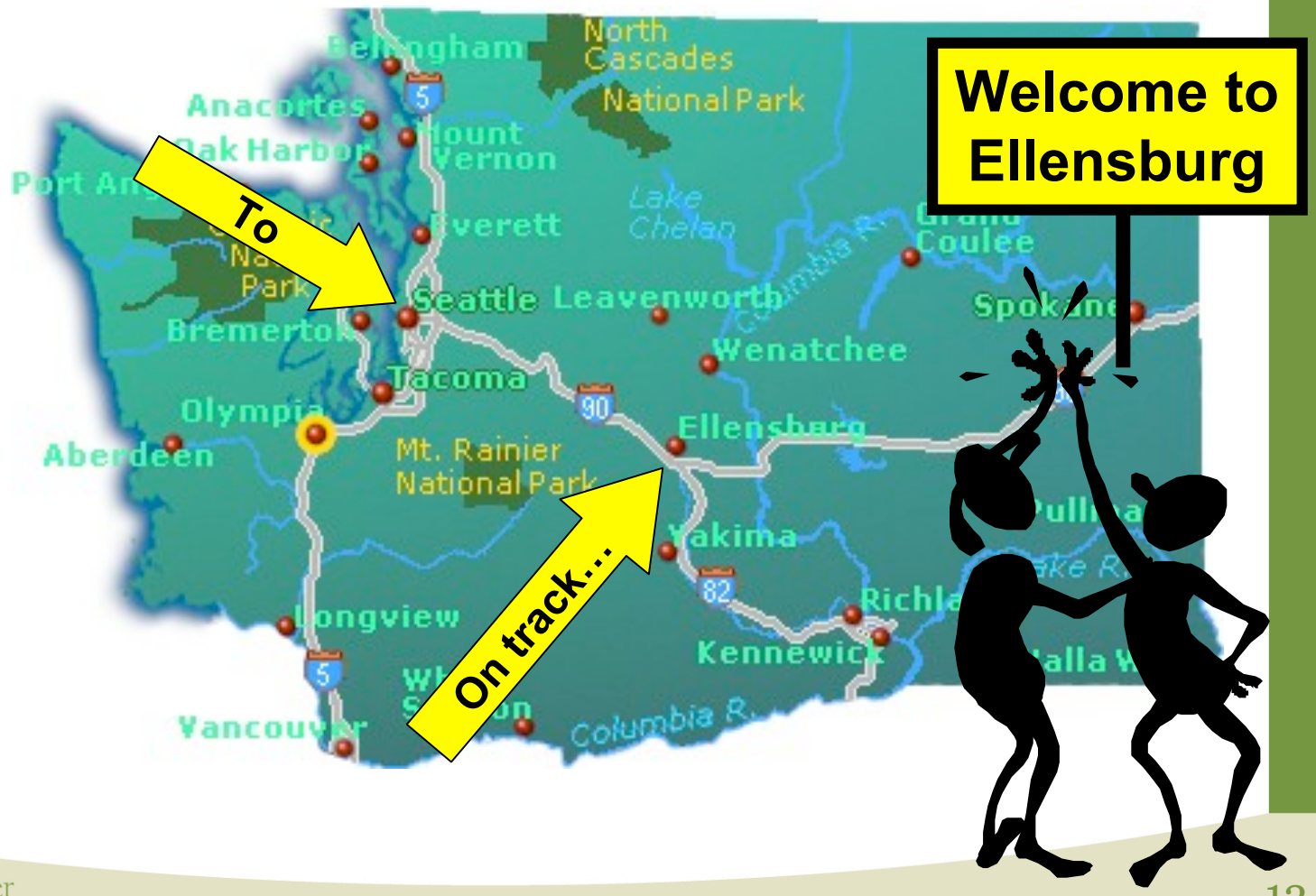


Fluency as Applied to Progress Monitoring: Measuring how we get from Point A to Point B Effectively and Efficiently

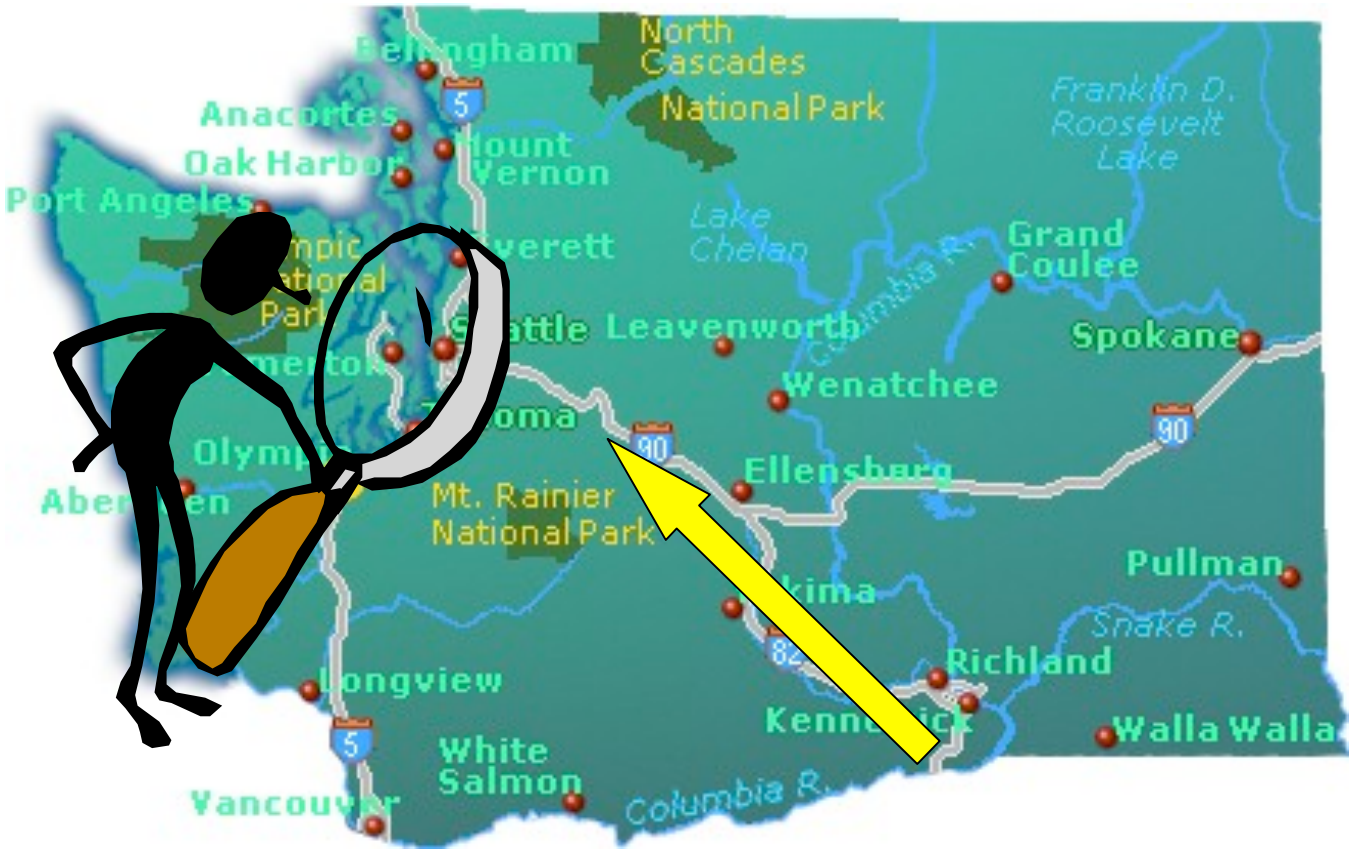


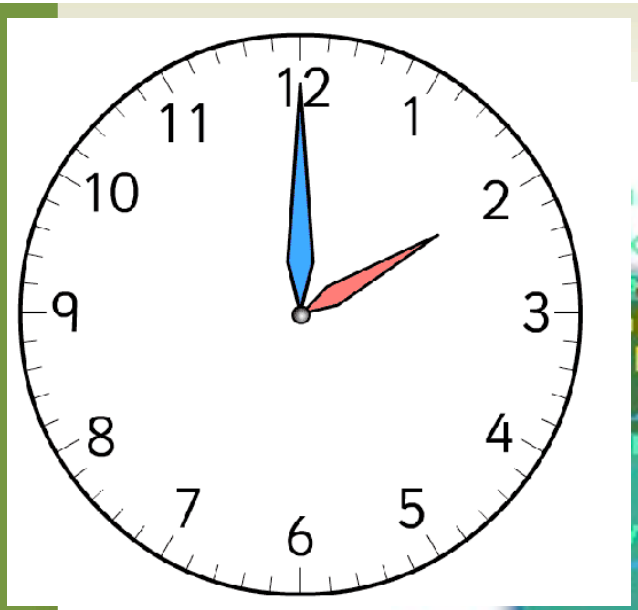
Accuracy


From
To
North Cascades National Park
Franklin D. Roosevelt Lake
Lake Chelan
Oak Harbor
Mount Vernon
Port Angeles
Olympic National Park
Everett
Seattle
Leavenworth
Spokane
Wenatchee
Tacoma
Ellensburg
Mt. Rainier National Park
Pullman
Yakima
Snake R.
Richland
Kennewick
Walla Walla
White Salmon
Columbia R.
90
5
82

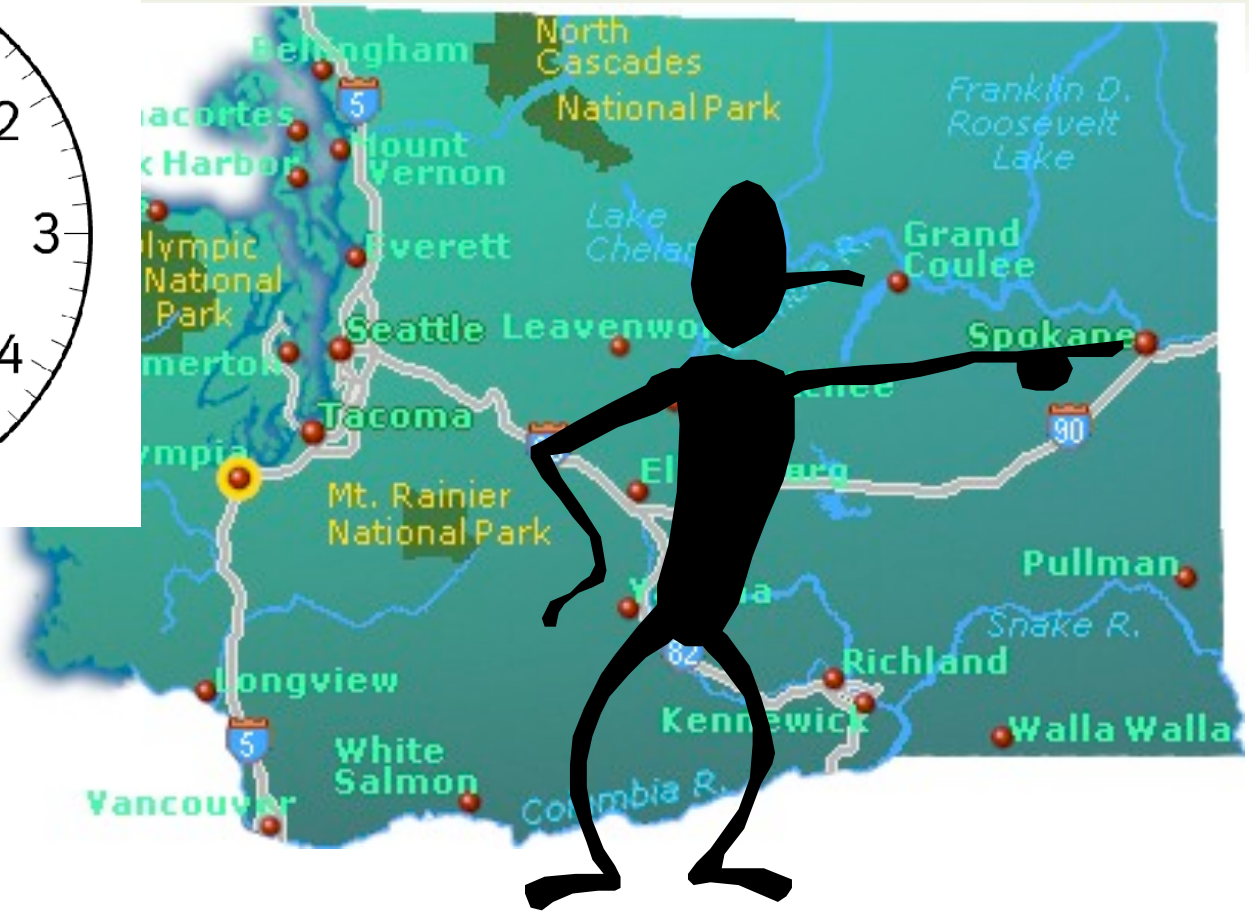

To
On track…
Welcome to Ellensburg
North Cascades National Park
Anacortes
Mount Vernon
Everett
Lake Chelan
Seattle
Leavenworth
Wenatchee
Tacoma
Olympia
Aberdeen
Mt. Rainier National Park
Ellensburg
Yakima
Kennewick
Longview
Vancouver
Columbia R.
Coulee
5
90
82


Bellingham
North Cascades
National Park
Anacortes
Oak Harbor
Mount Vernon
Port Angeles
Olympic National Park
Everett
Lake Chelan
Grand Coulee
Seattle
Leavenworth
Bremerton
Wenatchee
Tacoma
Olympia
Ellensburg
Aberdeen
Mt. Rainier National Park
Pullman
Yakima
Snake R.
Richland
Longview
Kennewick
Walla Walla
White Salmon
Vancouver
Columbia
Welcome to Oregon
Oops…

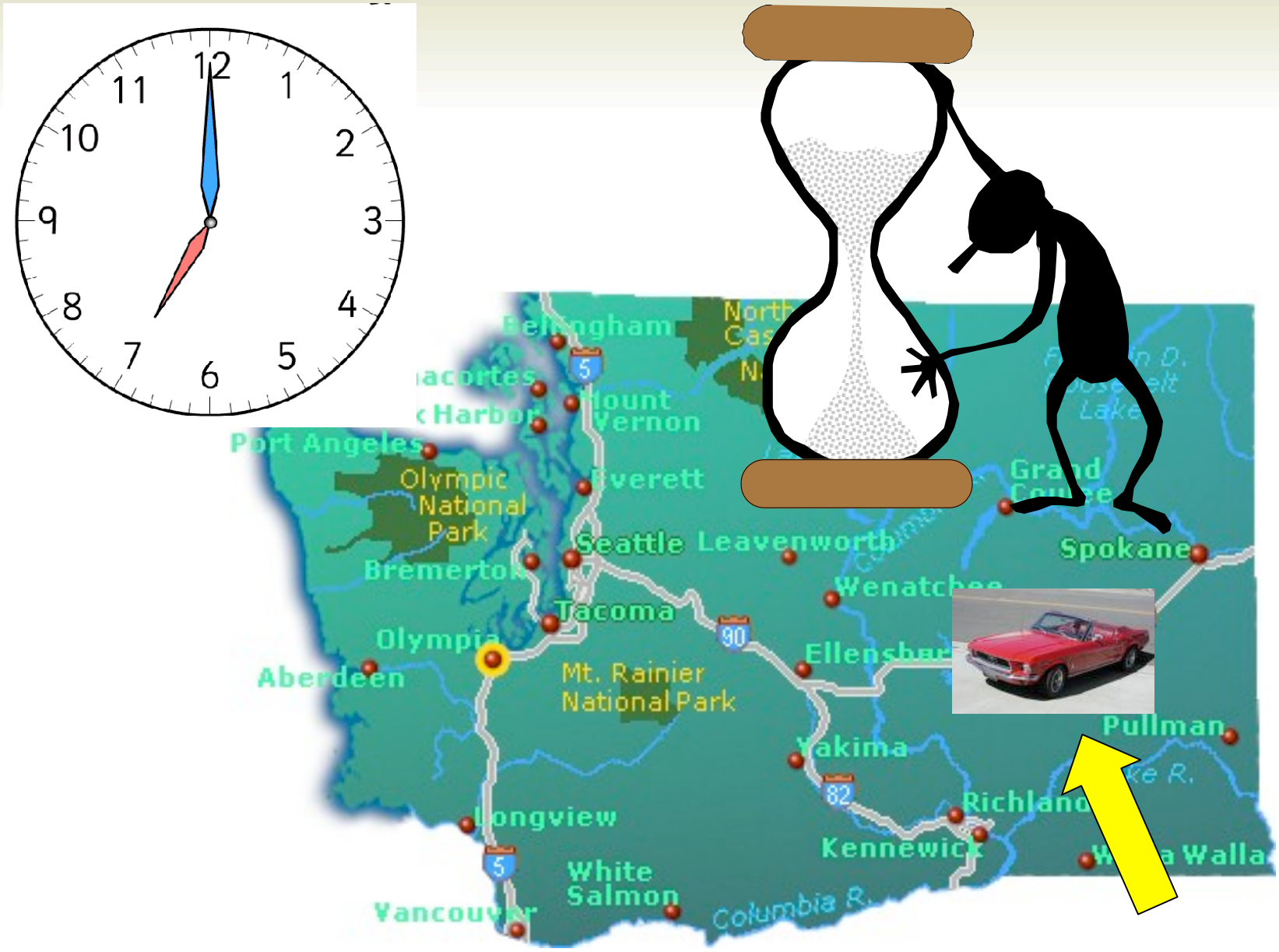

North Cascades
National Park
Franklin D. Roosevelt Lake
Anacortes
Oak Harbor
Port Angeles
Lake Chelan
Grand Coulee
Leavenworth
Spokane
Wenatchee
Ellensburg
Mt. Rainier National Park
Pullman
Snake R.
Richland
Walla Walla
Longview
White Salmon
Columbia R.
Vancouver
5
90



Rate



Mapquest: 4 Hours, 16 Minutes


12
1
2
3
4
5
6
7
8
9
10
11
Bellingham
Mount Vernon
Port Angeles
Olympic National Park
Everett
Seattle
Leavenworth
Spokane
Bremerton
Wenatchee
Tacoma
Olympia
Aberdeen
Ellensburg
Mt. Rainier National Park
Pullman
Yakima
Richland
Kennewick
Longview
White Salmon
Columbia R.
5
90
82

Critical Consideration of Efficient Progress Monitoring

At the risk of sounding overly dramatic…

struggling students have a relatively short window of opportunity to catch up to their typically-achieving peers. Not to put any pressure on teachers, but we must have a sense of urgency, or else we may lose these kids. We should never give up on them, but if the children continue to struggle and fall further behind, the likelihood for successful remediation is lessened. So rate and accuracy are critical when it comes to efficient PM and helping the children become typically achieving peers.

Issue:

Cost-benefit Ratio for Teachers et al.

What does the test provide?
How much teacher time is involved?
Is the time invested worth it?
How much is too much?
Pick and choose – cafeteria plan

progress monitoring: a set of techniques for assessing student performance on a regular and frequent basis ***(R. Quenemoen, M. Thurlow, R. Moen, S. Thompson, A. Blount Morse)***

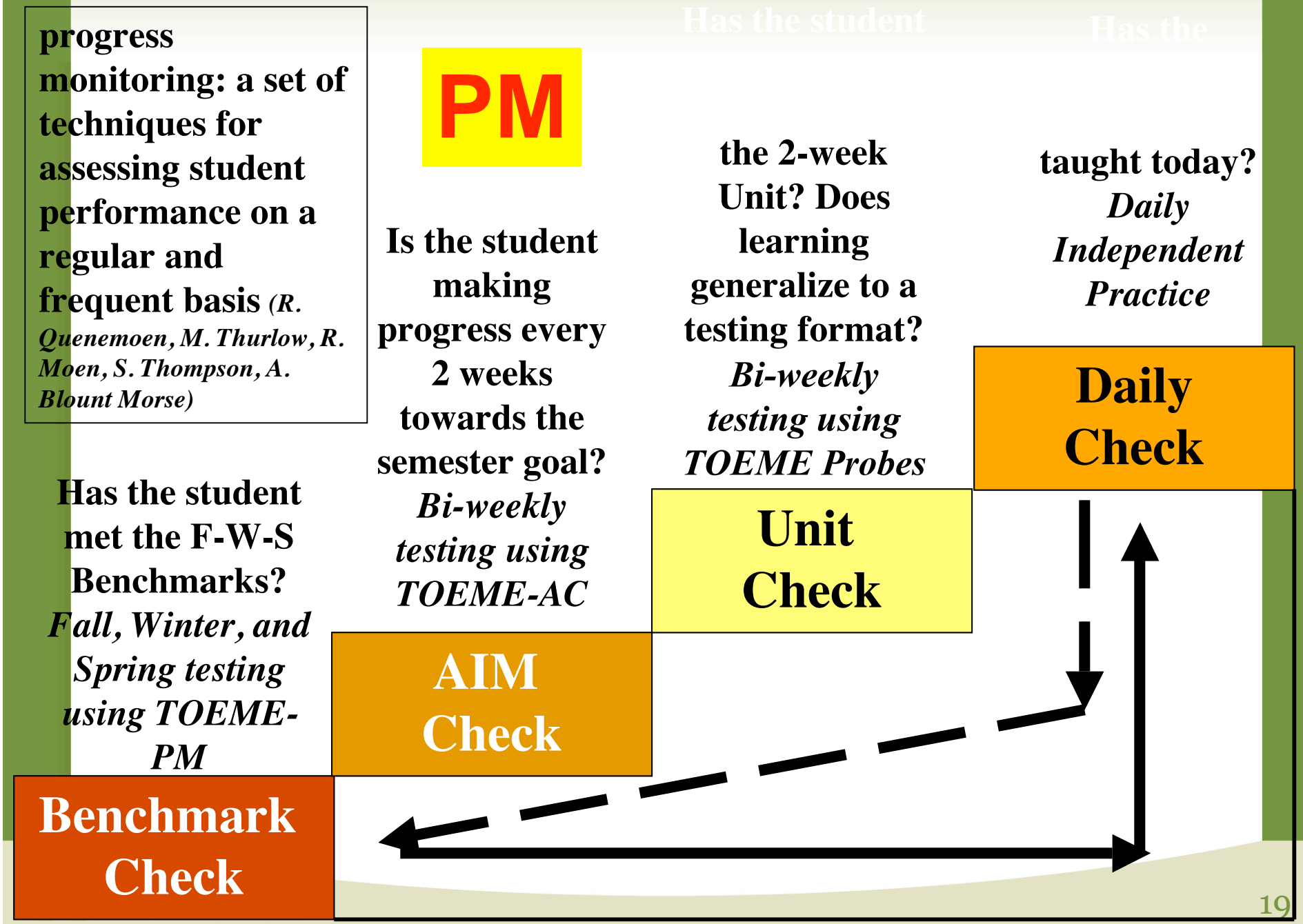
PM

Has the student met the F-W-S Benchmarks? ***Fall, Winter, and Spring testing using TOEME-PM***

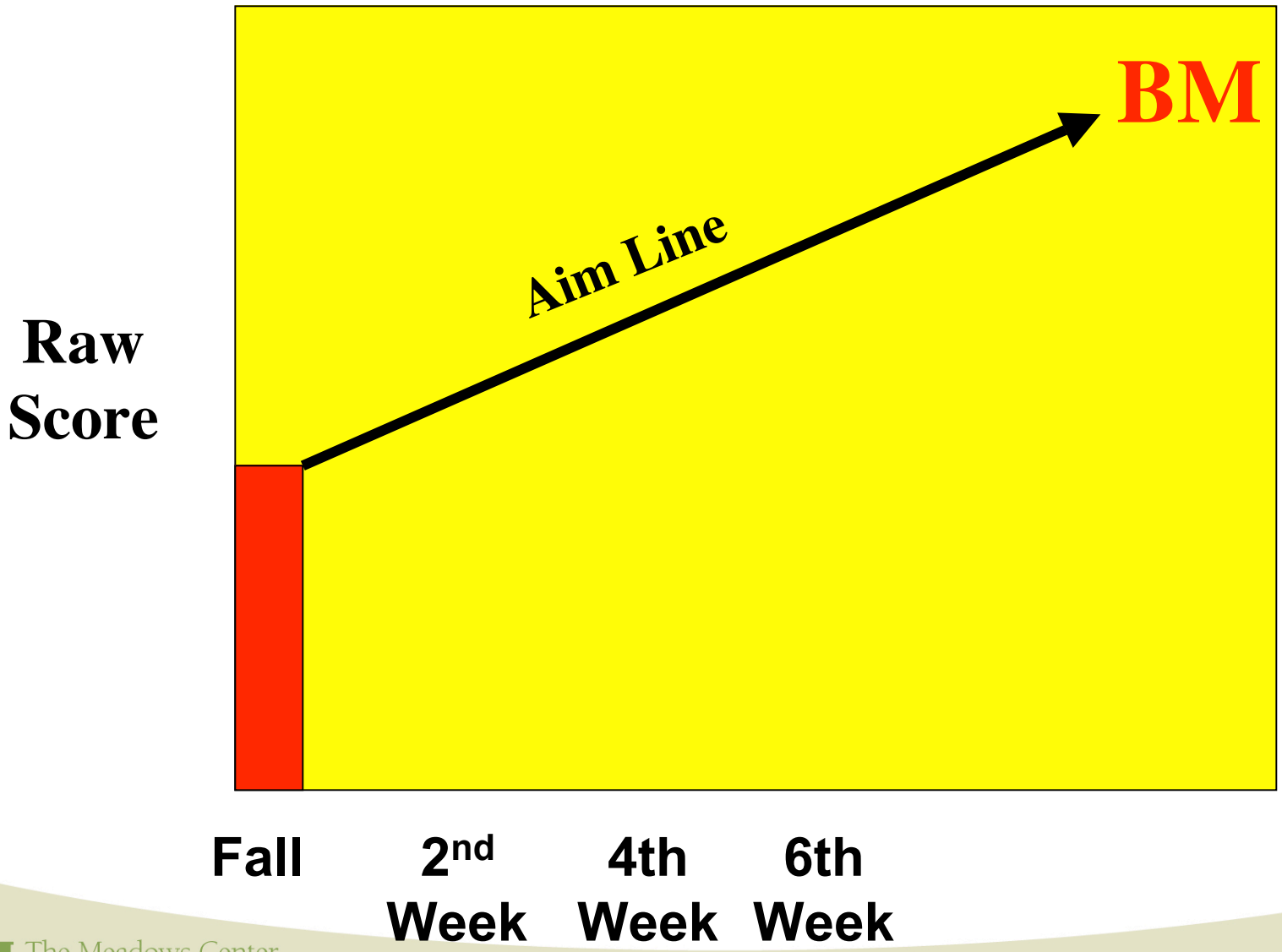
Is the student making progress every 2 weeks towards the semester goal? ***Bi-weekly testing using TOEME-AC***

the 2-week Unit? Does learning generalize to a testing format? ***Bi-weekly testing using TOEME Probes***

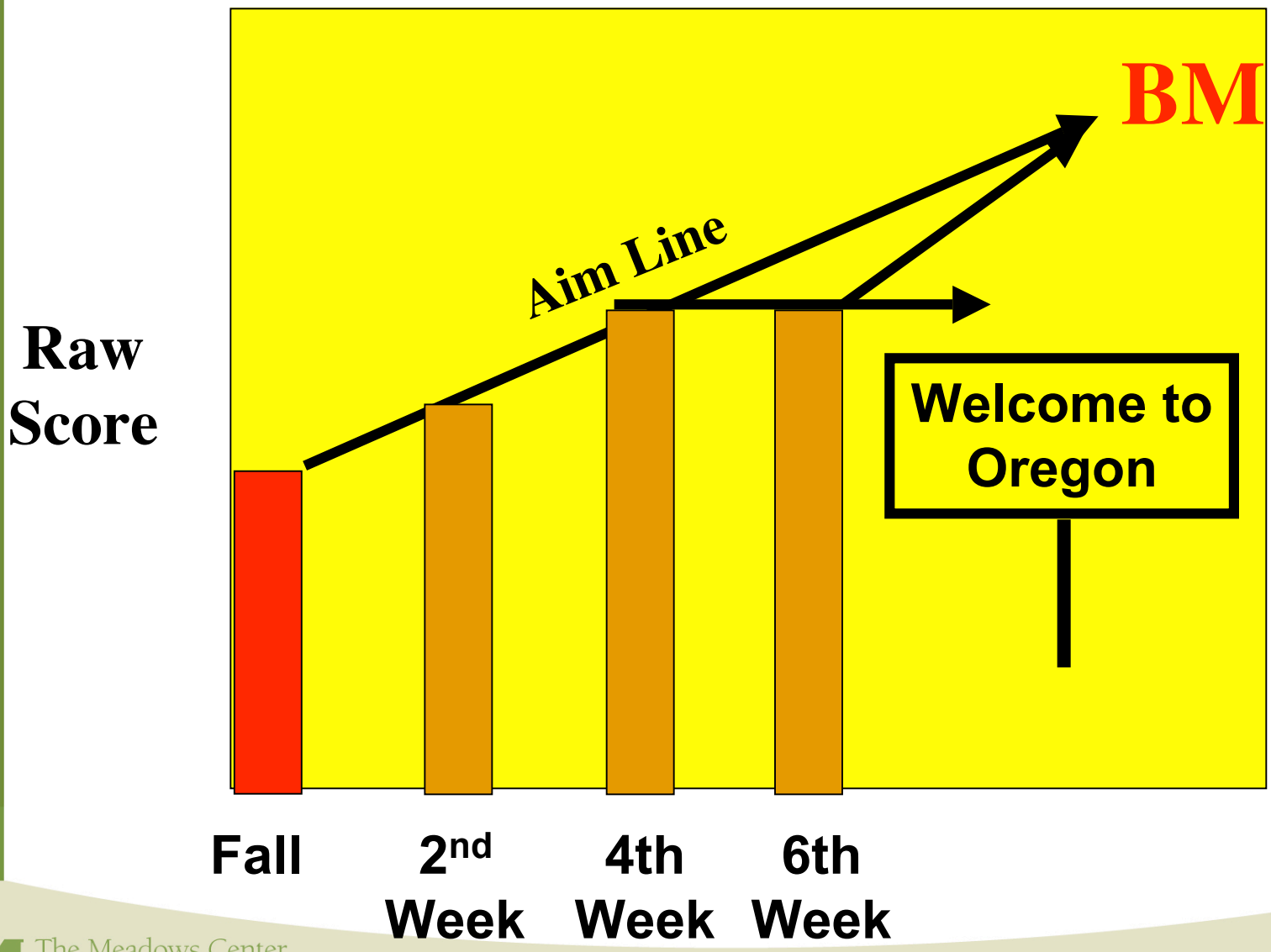
taught today? ***Daily Independent Practice***



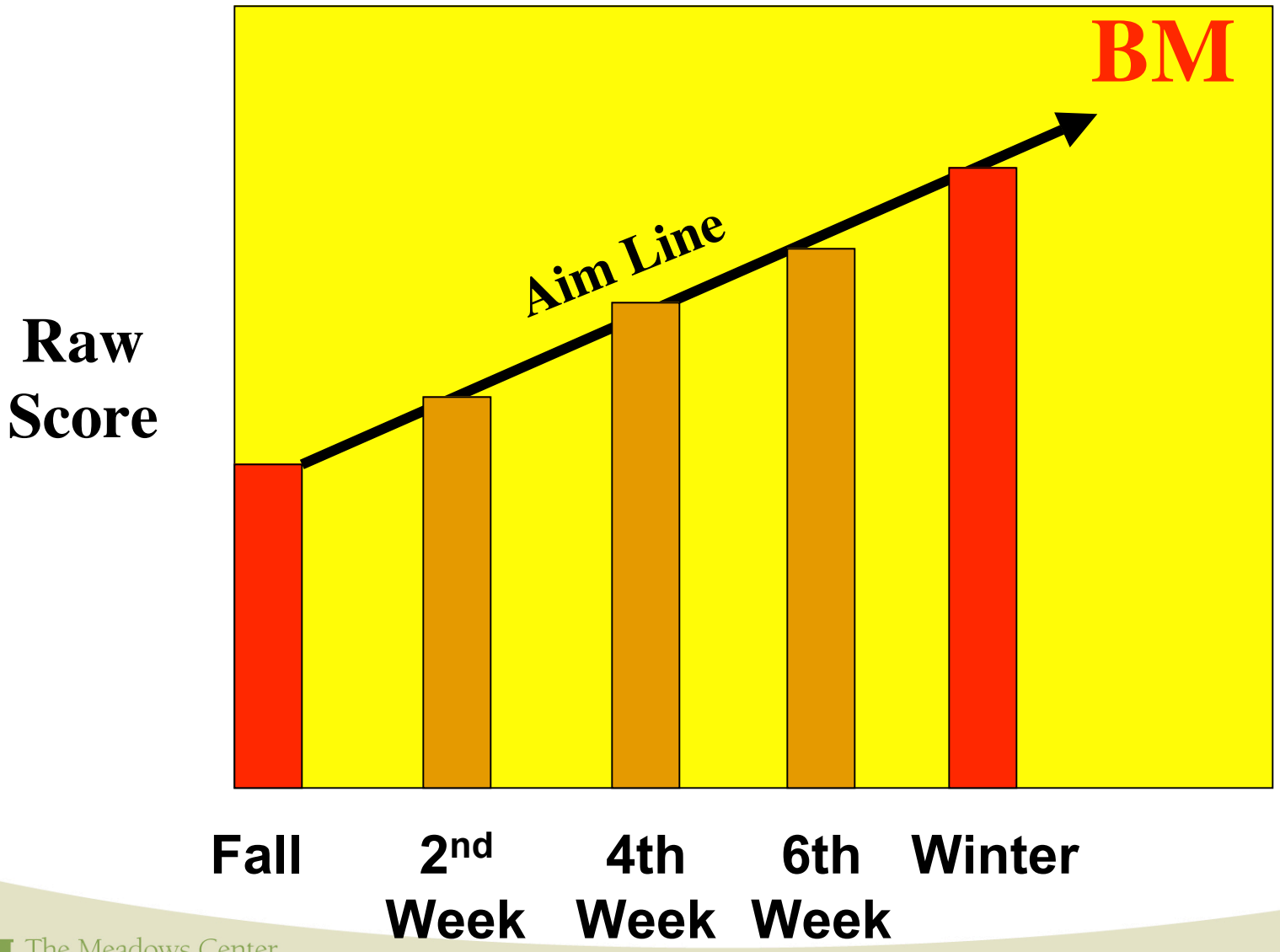
Use Benchmark Check to identify struggling students and create a plan (and aim line) for catching up.



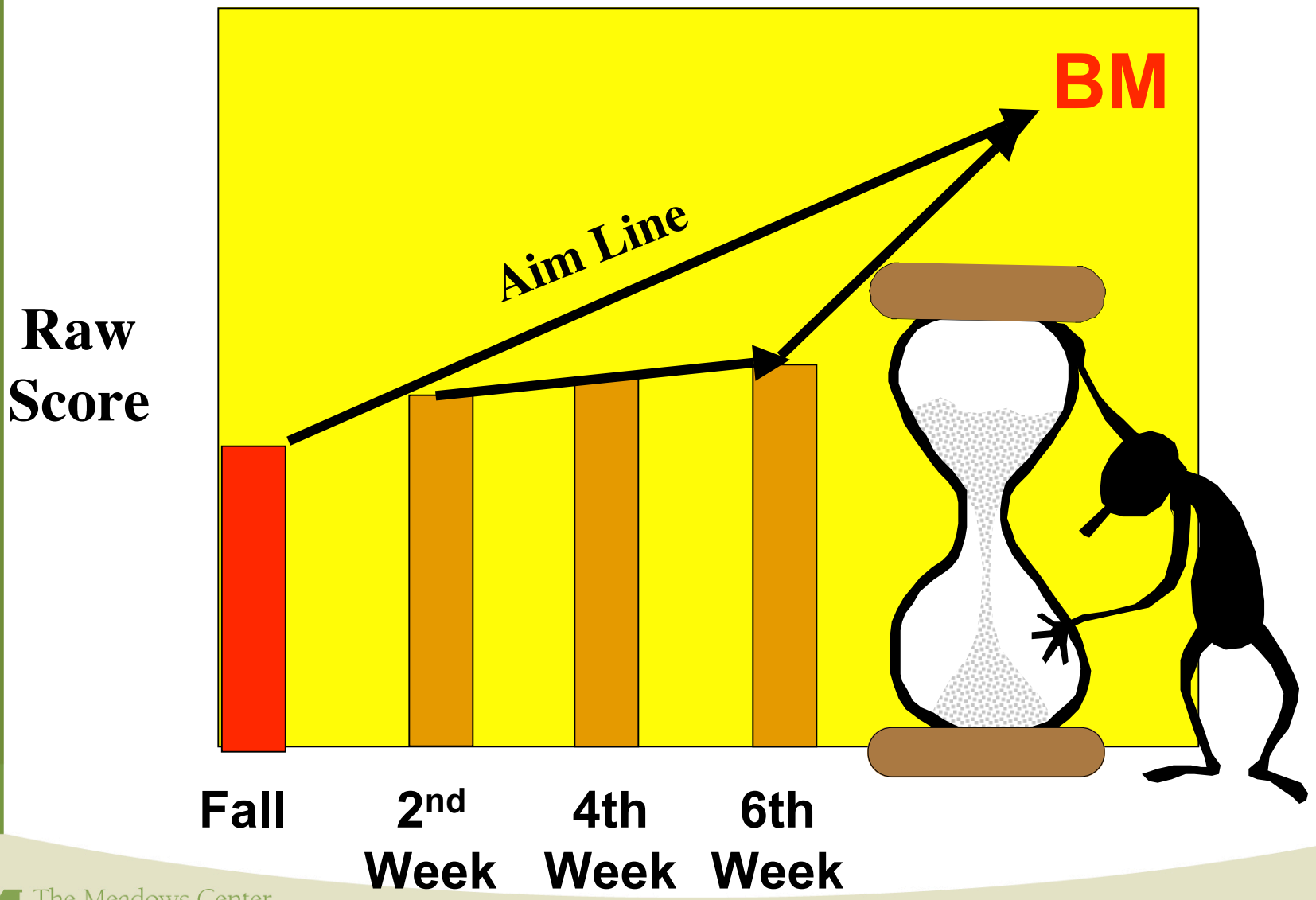
Use Aim Checks: If you take a wrong turn, get back on track.



Keep on Track



If progressing too slowly, reset the pace.



Assessment Options

- **Buy a commercially-published test**
- **Help field test a developed instrument**
- **Build your own instrument**

http://www.interventioncentral.org/htmdocs/interventions/cbmwarehouse.php

Buy a commercially-published test

- Check items against curriculum
- Check technical characteristics (norms, reliability, validity)
- Check Budget
- Purchase or keep looking

Help field test a developed instrument

- Check items against curriculum
- Check technical characteristics (norms, reliability, validity)
- Administer test(s)
- Share results

By the way: We have one you can use

Build your own instrument

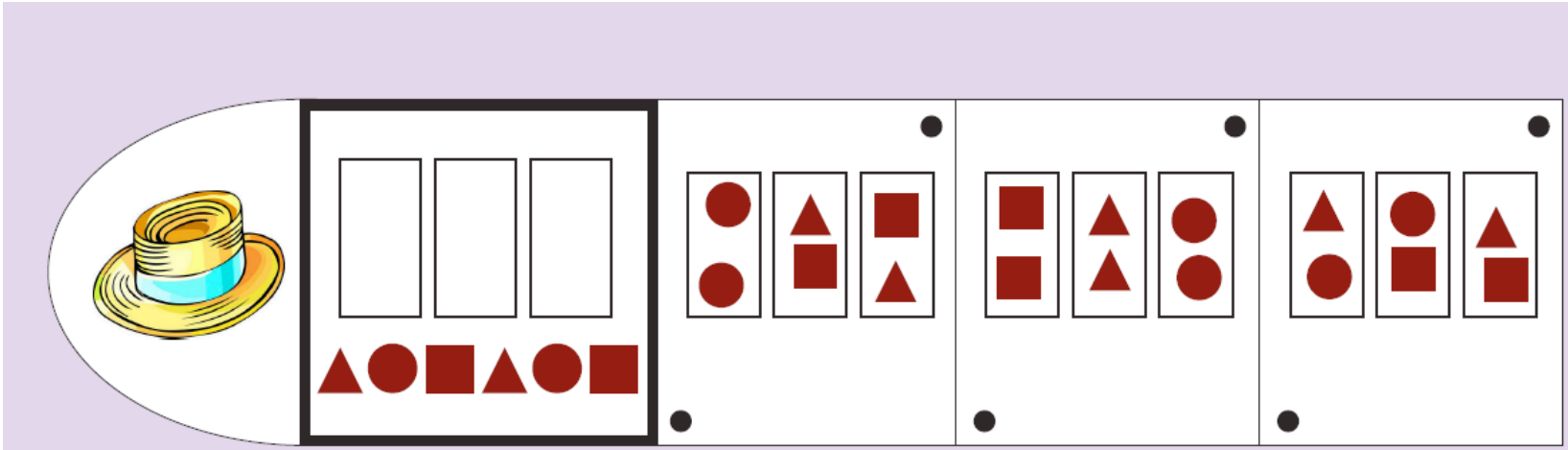
- Check Scope and Sequence of your curriculum
- Select subtests and items; create multiple forms
- Check for technical adequacy (develop norms, check for reliability and validity)
- Administer test(s)
- Interpret results

1.3.A Compare and sort a variety of two- and three-dimensional figures according to their geometric attributes.

1.3.B Identify and name two-dimensional figures, including those in real-world contexts, regardless of size or orientation.

1.3.C Combine known shapes to create shapes and divide known shapes into other shapes.

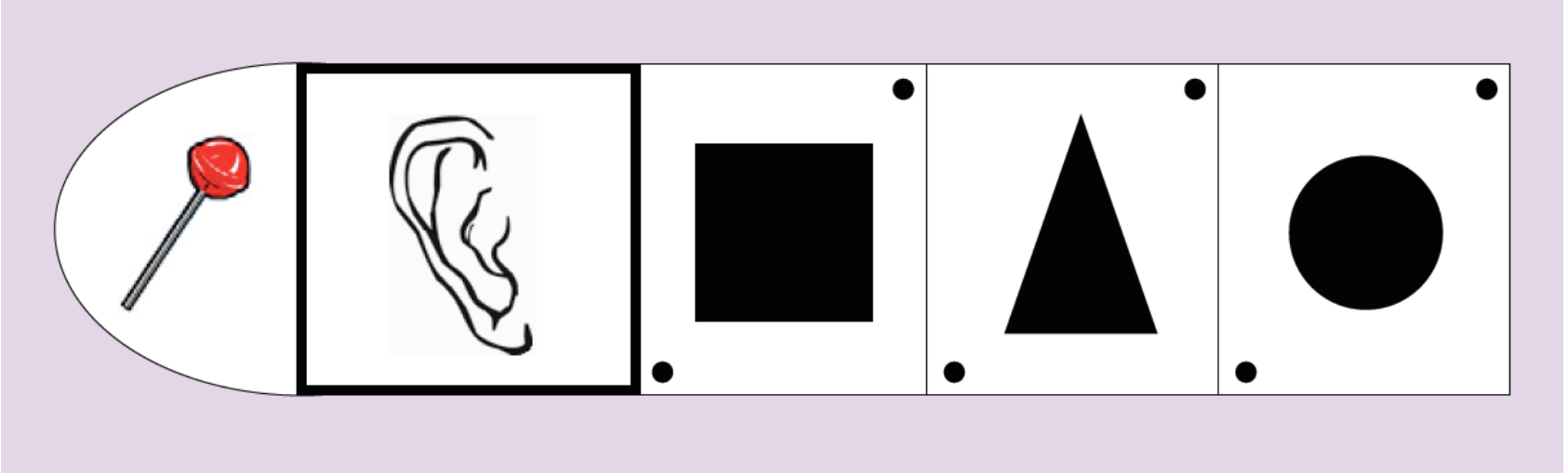
From Washington Standards



1.3.A Compare and sort a variety of two- and three-dimensional figures according to their geometric attributes.

1.3.B Identify and name two-dimensional figures, including those in real-world contexts, regardless of size or orientation.

1.3.C Combine known shapes to create shapes and divide known shapes into other shapes.



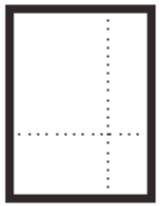
1.3.A Compare and sort a variety of two- and three-dimensional figures according to their geometric attributes.

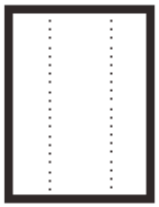
1.3.B Identify and name two-dimensional figures, including those in real-world contexts, regardless of size or orientation.

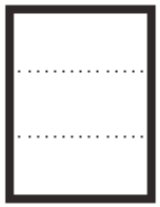
1.3.C Combine known shapes to create shapes and divide known shapes into other shapes.

22. Carla wanted to cut her sheet of paper into four equal parts. Mark the answer that shows how she could cut her paper into four equal parts.

A 

C 

B 

D 

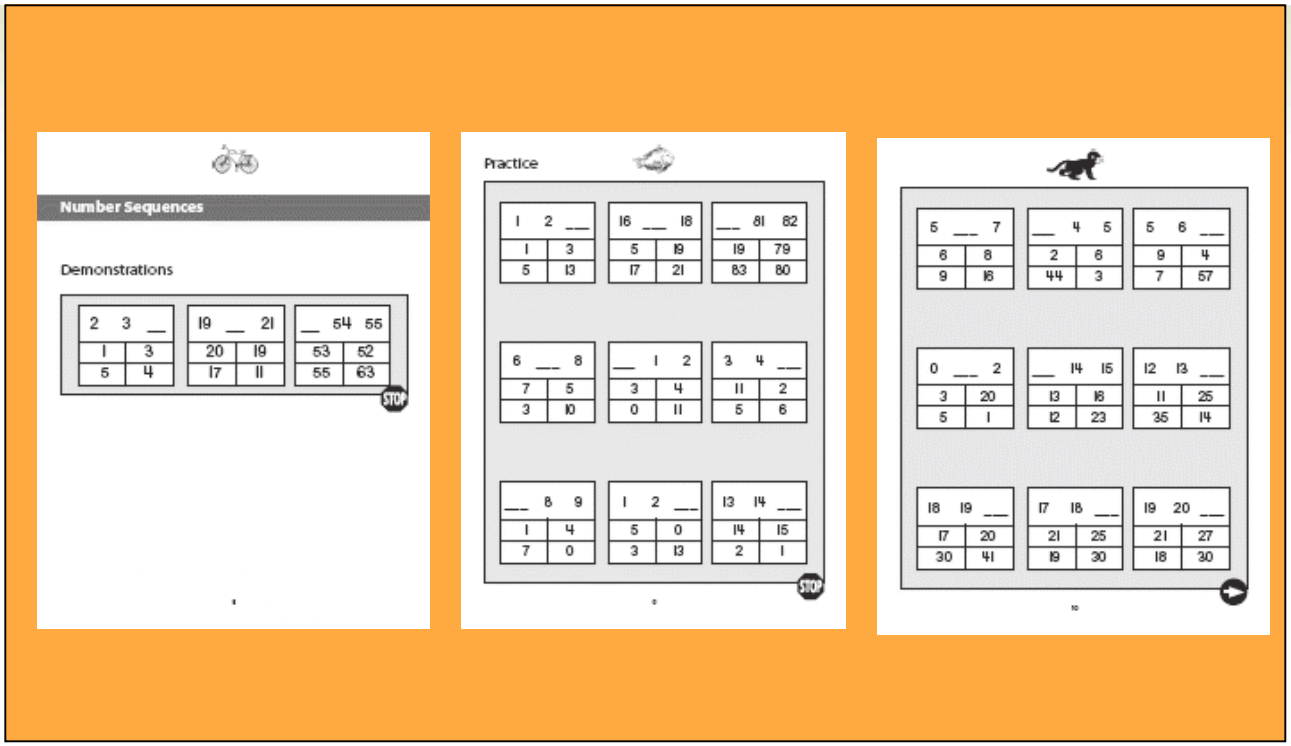
Building Fluency Measures

- **Consider the instructional content – for kindergarten children, we focus on number sense and quantitative reasoning; we add operations and math problem solving as kids mature**
- **Decide whether to build group- or individually-administered measures**
- **Decide on time limits (usually 1 or 2 minutes, depending on format)**
- **Create a set of administration and scoring procedures that are relatively easy for students and teachers**

Timed Tests for Fluency

Consider building fluency measures. Students can be given 1 or 2 minutes to do as many items as they can. Students can be given longer for Word Problem Solving.

Note



Consider creating all tests with three sections.

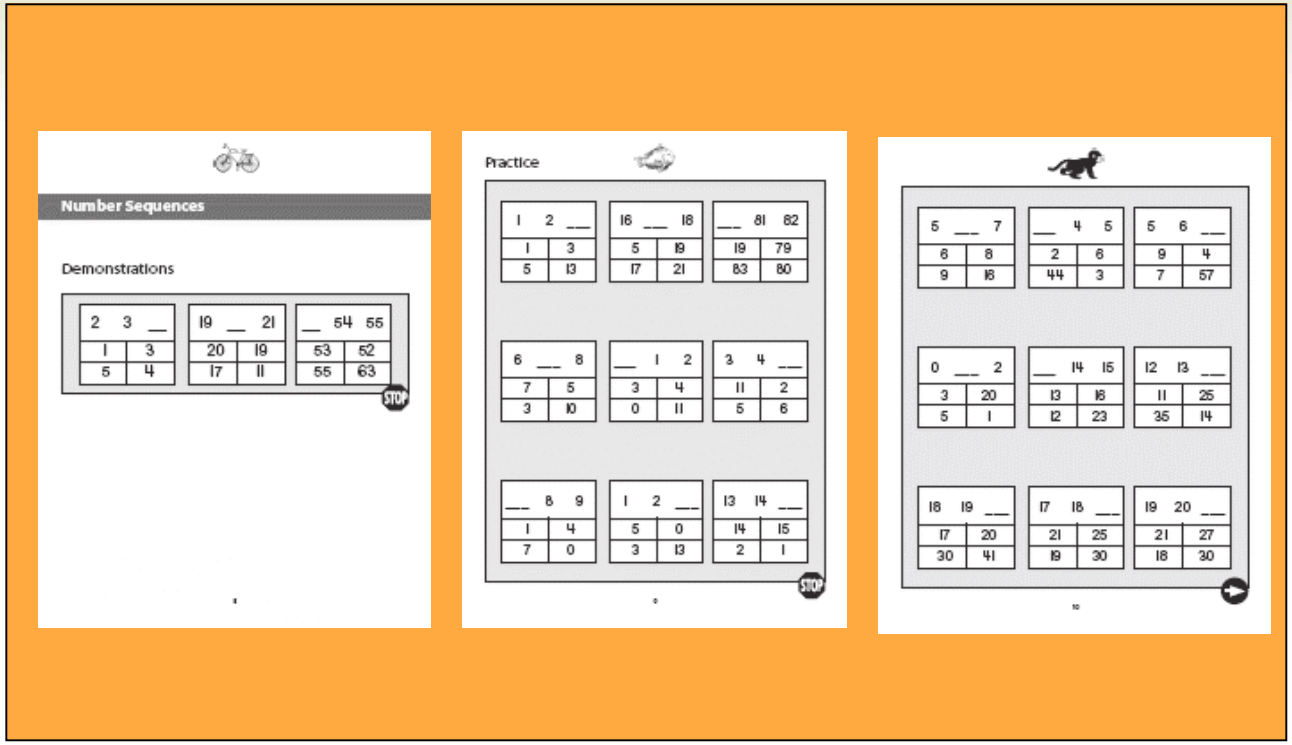
1. **Demonstrations**
2. **Practice**
3. **Test items**

Demonstration items **are designed to introduce the test and show students how they are to mark their answers. The examiner models how to respond to test items.**

Practice items **are designed to give students an opportunity to mark their answers and get a sense of time limits. Students are given 30 seconds to respond to one page of items. It is important for students to do the practice items to make sure that students know how to mark their answers in a timed condition.**

Test items **are presented across several pages; and students are given 2 minutes to respond to as many items as they can. It is extremely rare for students to complete all items in the 2-minute span, especially in the fall.**

Note



Consider creating tests with three sections.

1. **Demonstrations**
2. **Practice**
3. **Test items**

Using Grade 1 Strategic Counting as an example…

Number Sequences

Notice the page markers.

Demonstrations

2	3	__
1	3	
5	4	

19	__	21
20	19	
17	11	

__	54	55
53	52	
55	63	

STOP

Practice

1	2	__
1	3	
5	13	

16	__	18
5	19	
17	21	

__	81	82
19	79	
83	80	

6	__	8
7	5	
3	10	

__	1	2
3	4	
0	11	

3	4	__
11	2	
5	6	

__	8	9
1	4	
7	0	

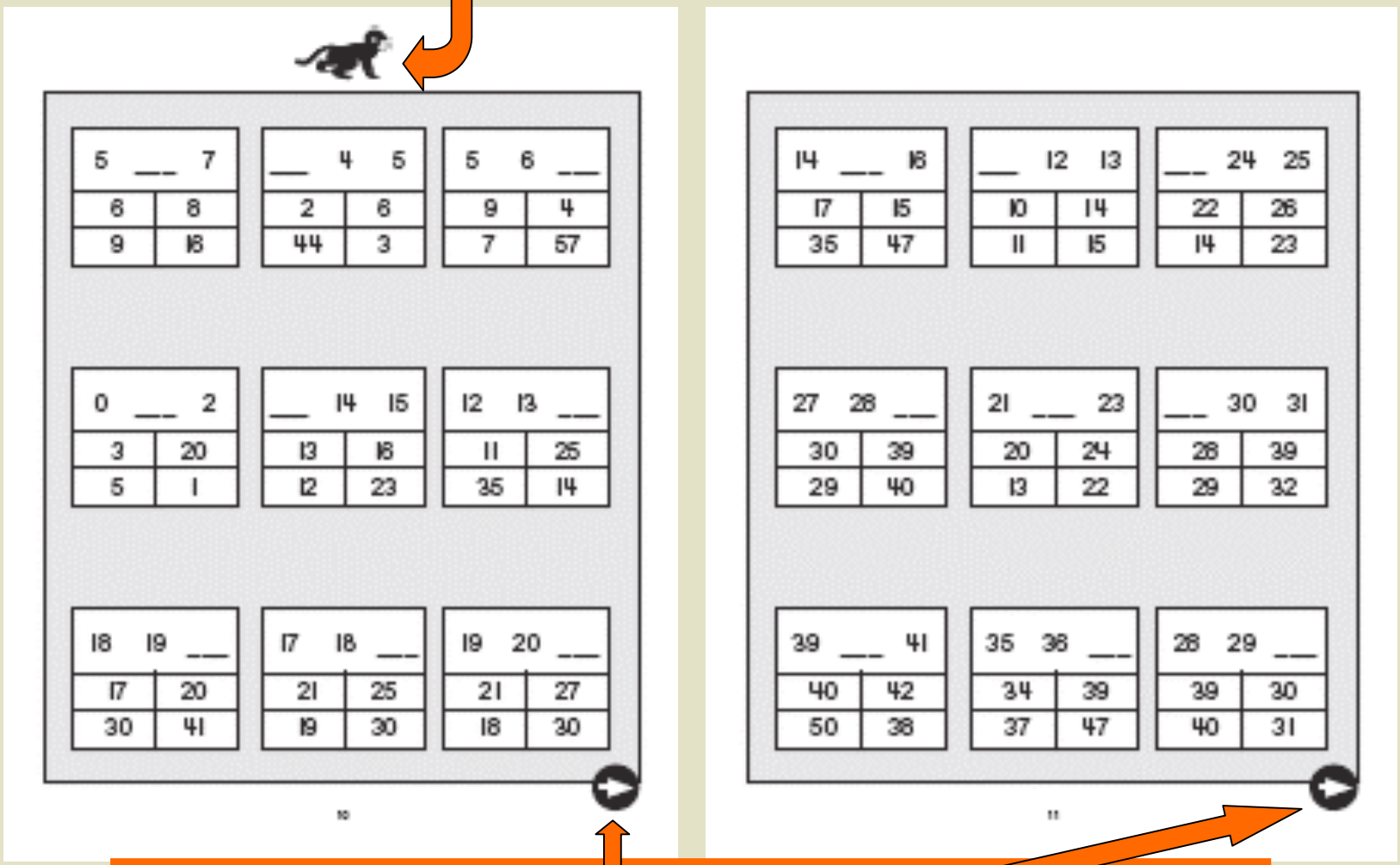
1	2	__
5	0	
3	13	

13	14	__
14	15	
2	1	

STOP

Notice the "STOP" signs.

Notice the page marker.



5 ___ 7		___ 4 5		5 6 ___	
6	8	2	6	9	4
9	18	44	3	7	57

0 ___ 2		___ 14 15		12 13 ___	
3	20	13	18	11	25
5	1	12	23	35	14

18 19 ___		17 18 ___		19 20 ___	
17	20	21	25	21	27
30	41	19	30	18	30

14 ___ 18		___ 12 13		___ 24 25	
17	15	10	14	22	26
35	47	11	15	14	23

27 28 ___		21 ___ 23		___ 30 31	
30	39	20	24	28	39
29	40	13	22	29	32

39 ___ 41		35 36 ___		28 29 ___	
40	42	34	39	39	30
50	38	37	47	40	31

Notice the “CONTINUE” arrows.

Establish Content Validity

- Select items representative of state standards (state adopted basals are helpful).
- Have experts verify that items relate to standards
- http://www.k12.wa.us/curriculuminstruct/mathematics/
- Field test and conduct item analyses

Establish Criterion-related Validity

- Administer the test and correlate results with established measures and teacher ratings
- Conduct analyses to demonstrate that the test is predictive of future performance

Establish Construct Validity

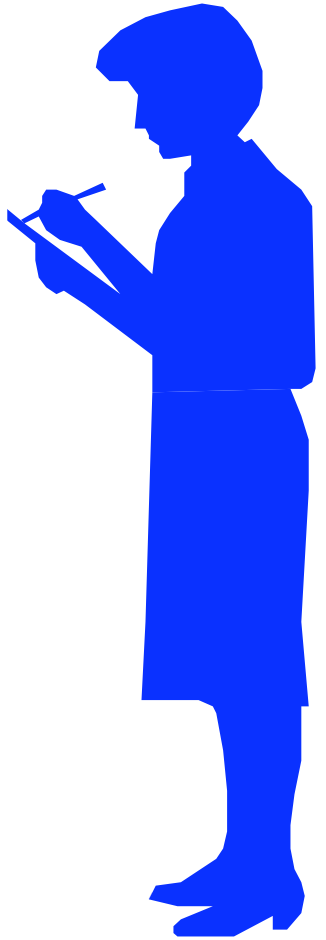
- Generate relative questions and test hypotheses (age related F/W/S, floor/ceiling effects, relate to other areas of achievement, differentiates among groups, shows intervention-related gains throughout the year)

Demonstrate Reliability – Internal Consistency, alternate forms, test-retest, inter-scorer

Establish normative data – at least 100 students at each age, 1000 overall, representative of the state/district

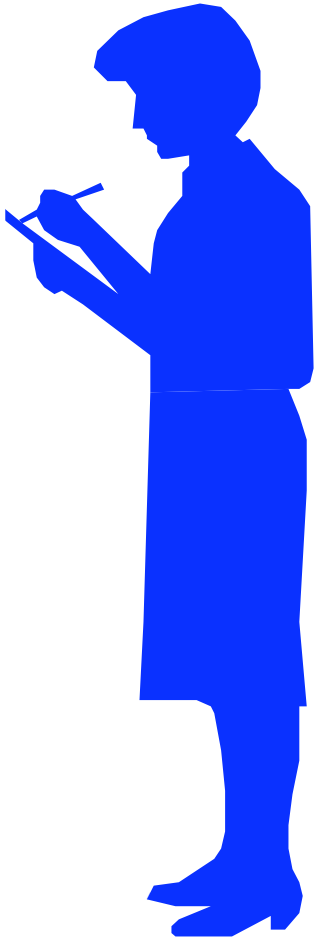
Something's missing…

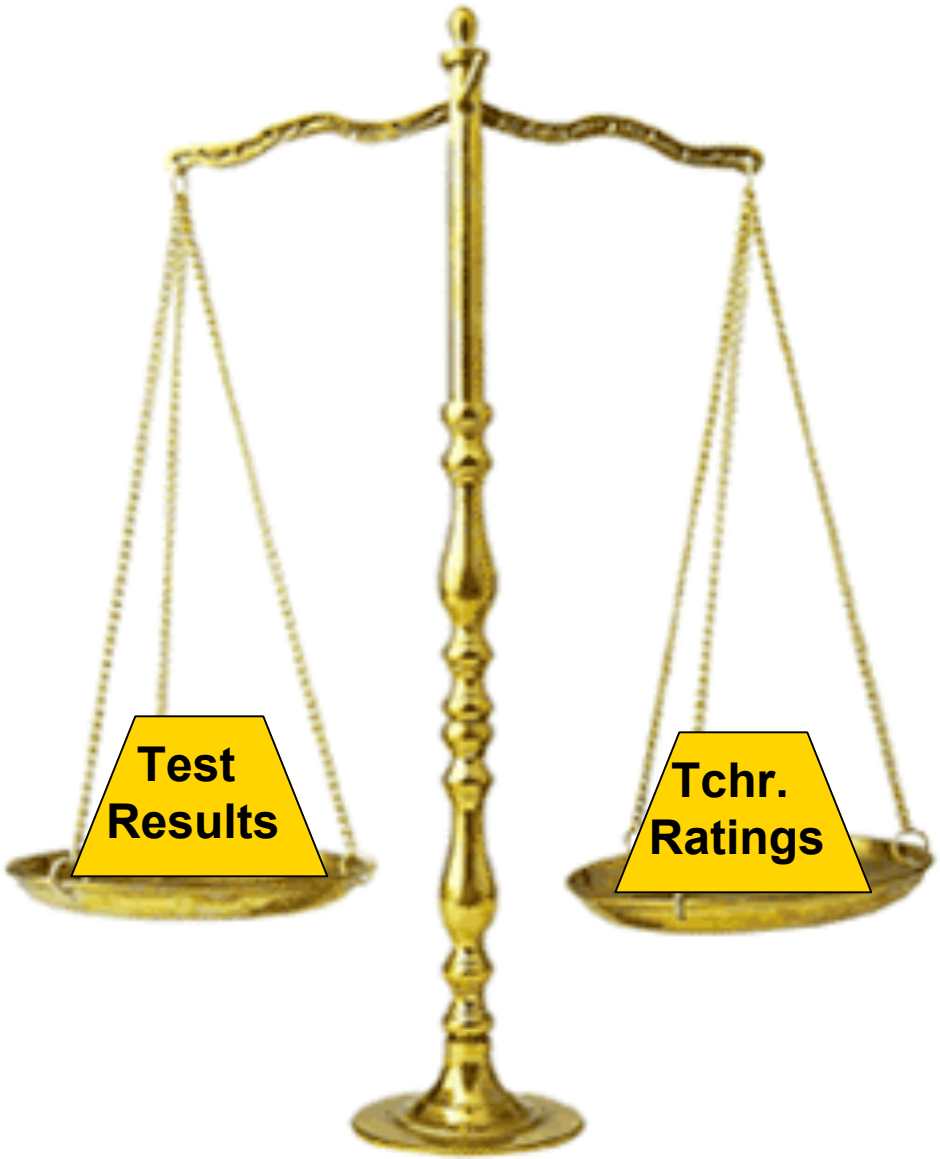
…Classroom teacher input. Research indicates that teacher ratings correlate with achievement measures to much the same extent as achievement tests correlate with one another.



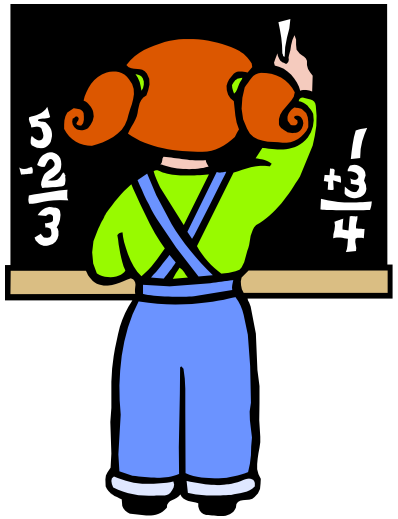
Academic and Behavior Compendium*.

Main Entry: com·pen·di·um
Pronunciation: k&m-'pen-dE-&m
Function: *noun*
Inflected Form(s): *plural* -di·ums *or* com·pen·dia /-dE-&/
Etymology: Medieval Latin, from Latin, saving, shortcut, from *compendere* to weigh together, from *com-* + *pendere* to weigh -- more at PENDANT
1 : a brief summary of a larger work or of a field of knowledge : ABSTRACT
2 a : a list of a number of items b : COLLECTION, COMPILATION




Test Results
Tchr. Ratings

Tier 2 Intervention Booster Lessons



Tier 2 Types of Boosters

- Concrete Representation
- Visual/Pictorial Representation
- Abstract/Numeric Representation

What content is important for Tier 2 based on the research?

Word Problem Solving: types of problems, extraneous information, multiple steps, contextualized

Number Knowledge and Relationships
- Counting: Rote, Rational, Counting Up/Back, Skip (2, 5, 10)
- Number Recognition & Writing: 0 - 99 (1st); 0 - 999 (2nd grade)
- Comparing & Grouping Numbers

Number Relationships of more, less,
- Relationships of one and two more than/less than
- Anchoring Numbers to 5 & 10 frames
- Part-part-whole Relationships (e.g., ways to represent numbers)

Numeric Sequencing

What content is important for Tier 2 based on the research?

Base 10 & Place Value
Making and counting: groups of tens and ones (1st grade); groups of hundreds, tens, and ones (2nd grade)
Using base-ten language (3 hundreds, 0 tens, 6 ones) and standard language (306) to describe place value

Reading and writing numbers to represent base ten models

Naming the place value held by digits in numbers

Addition & Subtraction Combinations

Identity Element and Properties
Fact Families
Counting & Decomposition Strategies (e.g., Addition: count on [+ 0, + 1, + 2], doubles, doubles +1, make 10 + more;
Subtraction: count down [-0, -1, -2, -3], count on

Procedures & Features of Tier 2 Intervention*

•Groupings: homogeneous grouping with 3 - 5 students per group

•Duration: 4 times per week for 25 minutes; PM 5th day

•Lesson Design: mixed (instructional content-IC), scaffolded, scripted interventions; explicit, strategic, "think aloud;" error correction; factual, procedural, and strategic learning

•Instructional Content: IC ranges focusing on difficult numbers; vocabulary; (e.g., greater than/less than); number, operation, quantitative reasoning; patterns/relationships/algebraic thinking; problem solving; other TEKS (implicit)

*Based on Research for Students with Difficulties/Disabilities

Procedures & Features of Tier 2 Intervention

- Representations: physical (concrete), visual (pictorial), abstract (numbers/symbols)

- Materials: number charts (100s), 5- and 10-frames, counters, cubes, number lines, base-ten materials, dot cards, fact cards, place value cards

- Progress monitoring: daily checks (independent practice); aim checks

- Stretch Your Skills

- Bubble answers

- Fidelity Checks

Sample Fidelity of Implementation Rating Scale

Teacher Behavior	Most of the time	Some of the time	Rare-ly	Not at all
	3	2	1	0
Intervention				
Teacher follows script sufficiently to ensure fidelity of implementation.				
Teacher implements each step (modeling, GP, IP) sufficiently to ensure fidelity of implementation.				
Teacher implements self-correct/EC following IP to ensure students learn IC.				
Instruction				
Teacher maintains brisk pace.				
Teacher provides corrective feedback immediately as needed.				
Teacher talk is kept to a minimum and is characterized with short requests "What answer?" "How many?"				
Teacher engages students throughout lesson with a response that is verbal, written, or hands-on.				
Teacher models using "think aloud."				

Intervention Description

- Ten Units of instruction
- Eight days of lessons per unit
- Each day involves
  - Warm-Up
  - 2 Lessons
    - Modeling
    - Guided Practice
    - Independent Practice

Instructional Schedule

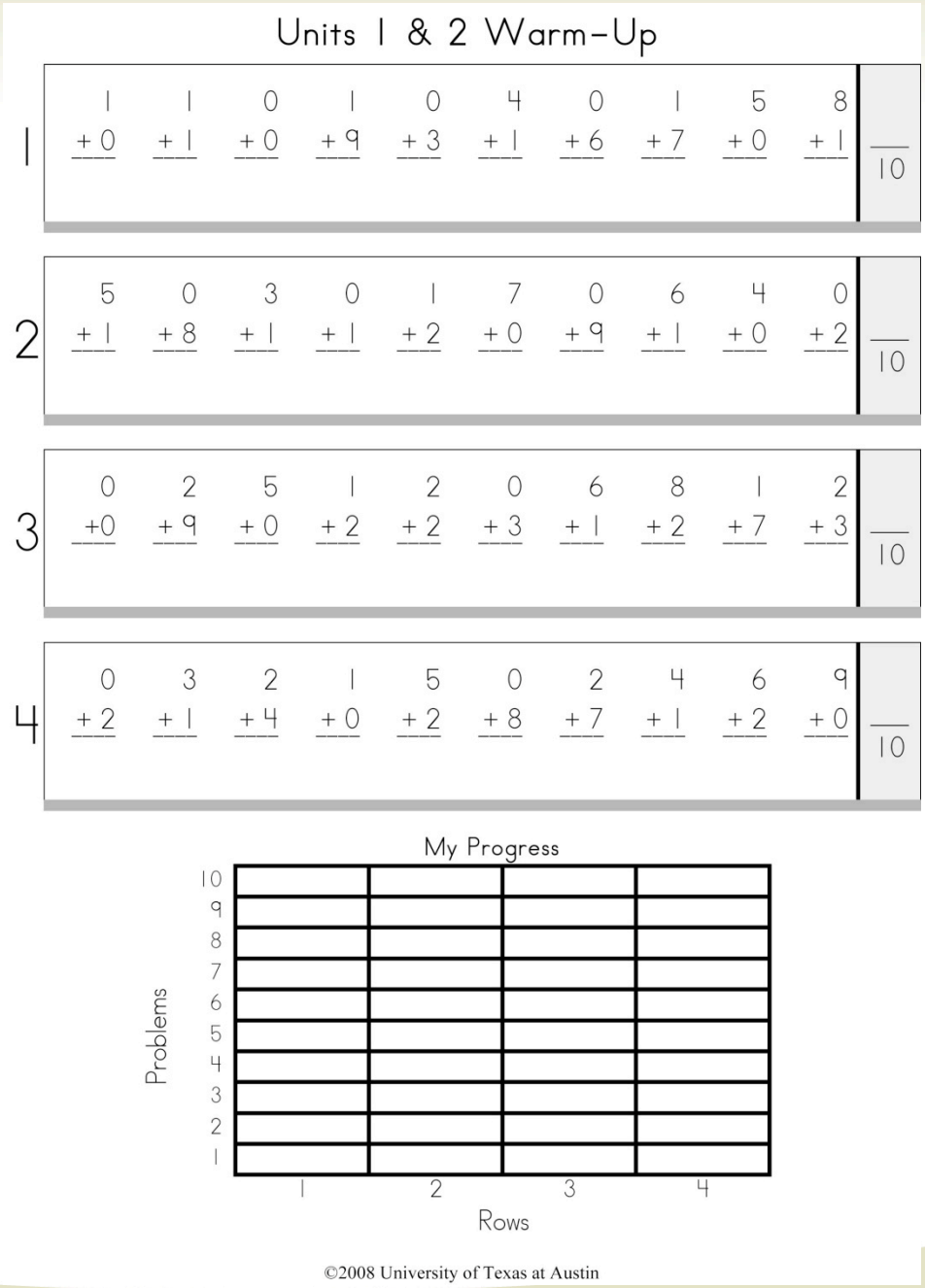
- Day 1, 3, 5, and 7
  - Warm-up: 3 minutes
  - Word-Problem Solving: 10 minutes
  - Ordering and Comparing Numbers: 10 minutes
- Day 2, 4, 6, and 8
  - Warm-up: 3 minutes
  - Addition and Subtraction Facts: 10 minutes
  - Relationships of Ten/Magnitude Comparisons: 10 minutes

Warm-Up Description

- 3 days per week
  - Fact Review (+/-0, 1, 2, 3, doubles facts 1-9)
  - 3 seconds to respond
  - Group and individual responses
    - Written responses
    - Oral responses

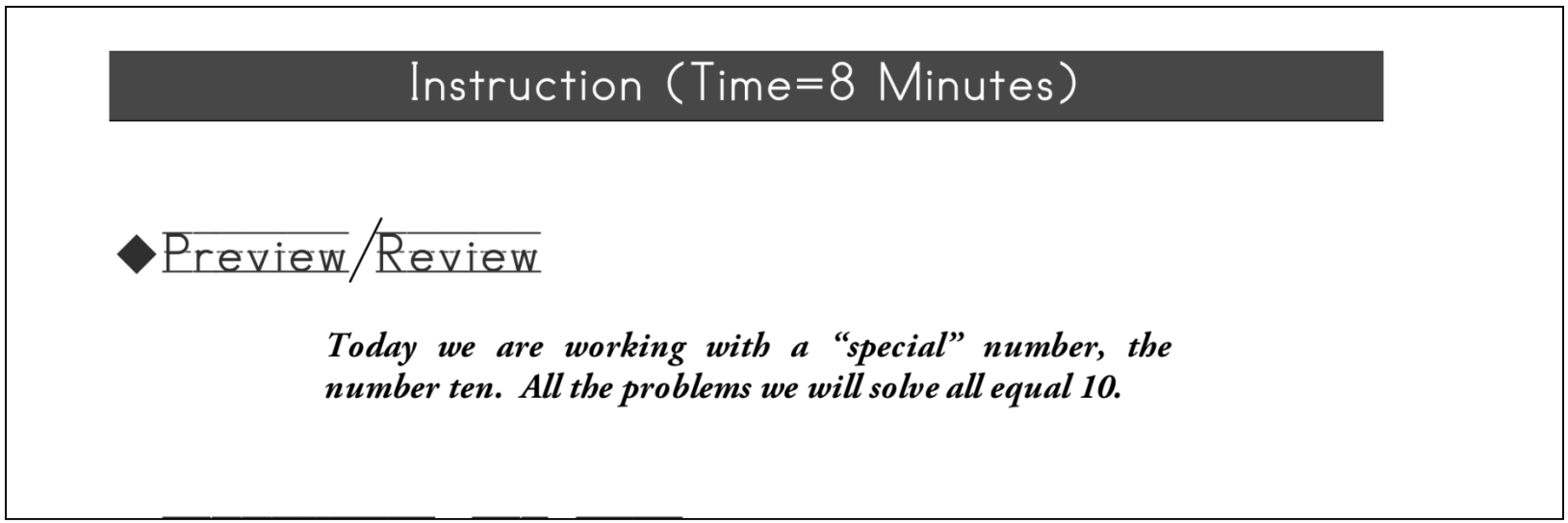
- 1 day per week
  - Recognizing Numbers
  - Writing Numbers

Warm-Up Example



Lesson Format

- Preview/Review
  - Briefly state or review the type of skill for the lesson



Lesson Format

- Modeling/Interactive Modeling
  - Teacher models the skill for the students
  - When skill has previously been introduced, teacher and students complete modeling together

◆Modeling= My Turn

1. Write on the wipe board, 8+ ___=10.

I need to figure out what goes in the blank. I will use ten connecting cubes and the ten-frame to solve the problem.

I put eight connecting cubes in my ten-frame.

How many more cubes do I need to make 10? (2, Put two more cubes, different color, in the empty spaces)

Yes, two more cubes make ten, so 8+2 equals 10. (Write 2 in the space on the problem)

What three numbers are in this family? (8, 2 and 10)

Lesson Format

- Guided Practice
  - Students complete practice with teacher
  - Error correction provided
  - Many opportunities to respond

◆Guided Practice (GP)= Our Turn

ERROR CORRECTION (If the student is having difficulty…)
Writing the number sentence: Allow student to copy teacher's number sentence ("match-to-sample")

2. Have students write 9+ ___=10, 8+____=10, 7+___=10 and 6+___=10 on the wipe boards.

   What is the number of the day? (10)

   Use the ten-frame to find the missing number. (Have students place the cubes in the ten-frame to solve the problems)

   Repeat steps with additional facts.

3. Have students write the turnaround fact for each number sentence.

4. Complete the guided practice worksheet.

Lesson Format

- Independent Practice
  - Students complete problems individually for 1 to 1 ½ minutes
  - Students check and correct with teacher

Independent Practice (IP)—*Your Turn* (Time=2)

1. Students will complete as many problems as possible in 1 minute, "Make Ten."
2. Students will correct any mistakes while checking and record the total number correct at the top of the page.

Sample Lessons

- Video Example

Word Problem Solving

- Strategy Instruction
  - Find the important information
  - Identify/cross out extraneous information
- Use manipulatives or draw a picture
- Write a number sentence

Word Problem Solving

UNIT

_____

Unit 3
Booster Lesson 2
WPS Day 1

Guided Practice

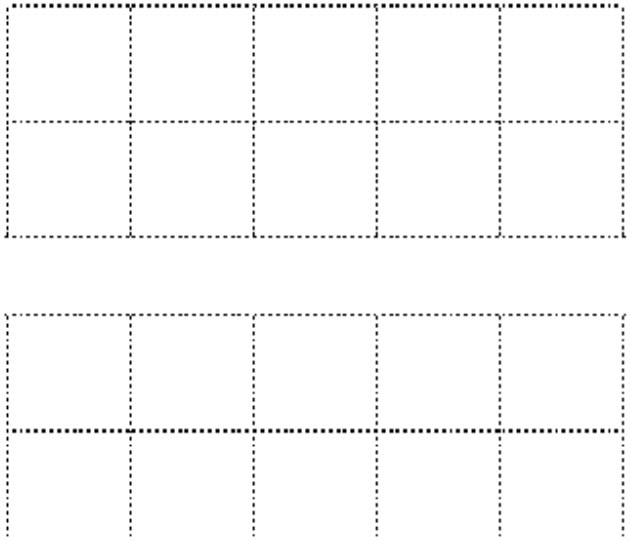
Identify It.

Sue has 4 cats.

She found 2 more cats.

How many cats does Sue have?

Show It.



Write the number sentence.

_____ ◯ _____ = _____

Choose the Number Sentence.

- 4 - 2 = 2
- 4 + 2 = 6

Ordering and Comparing Numbers

- Order numbers from least to greatest
- Identify missing numbers in a number sequence using strategies
- Use patterns to count (skip counting)

Ordering and Comparing Numbers

Unit 7 • Lesson 21
OCN • GP

Missing Numbers

27 28 ___		77 ___ 79	
22	28	76	78
29	92	79	66
74 75 ___		___ 47 48	
76	78	45	46
85	73	64	44
56 ___ 58		___ 71 72	
87	57	76	71
7	77	70	75
8 9 ___		32 ___ 34	
11	19	72	76
7	10	33	40
___ 78 79		10 ___ 12	
74	77	11	1
67	76	61	71

Unit 8 • Lesson 3
OCN • IP

Skip Counting By 2s, 5s & 10s
Write the number that comes next.

4	6	8	___	12	14
50	60	70	80	___	100
25	30	35	40	45	___
20	___	24	26	28	30
30	40	50	60	___	80
65	70	75	80	___	90
12	14	16	18	20	___
10	___	30	40	50	60
25	___	35	40	45	50
55	60	___	70	75	80

Addition and Subtraction Facts

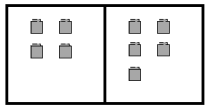
- Solve basic addition and subtraction facts
- Solve facts fluently
- Use strategies (Count on, Count down, Doubles, Doubles +1, Make 10 plus more)

Addition and Subtraction Facts

Unit 8 • Lesson 5
ASF • GP

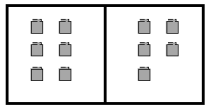
Doubles +1

1. 4 + 4 = ___



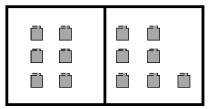
4 + 5 = ___

2. 5 + 5 = ___



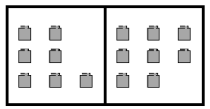
6 + 5 = ___

3. 6 + 6 = ___



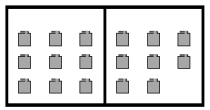
6 + 7 = ___

4. 7 + 7 = ___



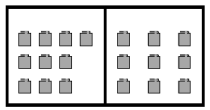
7 + 8 = ___

5. 8 + 8 = ___



9 + 8 = ___

6. 9 + 9 = ___



10 + 9 = ___

Unit 5 • Lesson 23
ASF • IP

Count-Back

1. 9 − 3 = ___

2. 1 − 1 = ___

3. 6 − 3 = ___

4. 4 − 3 = ___

5. 7 − 7 = ___

6. 5 − 3 = ___

7. 10 − 3 = ___

8. 7 − 3 = ___

9. 4 − 4 = ___

10. 8 − 3 = ___

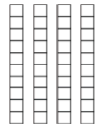
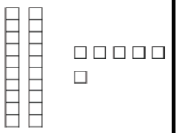
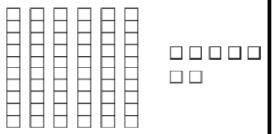
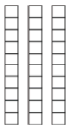
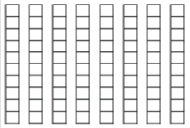
Relationships of Ten

- Identify a number represented by picture or objects
- Identify the “ones place,” “tens place,” and “hundreds place”
- Identify greater than and less than using pictures or objects and place value

Relationships of Ten

Unit 8 • Lesson 12
ROT • GP

Add 'Em

				Add Together + _____
23	7	8	26	
43	35	18	62	
				+ _____
37	13	31	4	
56	67	20	25	
				+ _____
80	8	15	4	
40	50	25	5	

Unit 8 • Lesson 12
ROT • IP

Adding BIG Numbers!

1 Tens Ones	2 Tens Ones	
3 Tens Ones	4 Tens Ones	
5 Tens Ones	6 Tens Ones	

Intervention Progress Monitoring

- Daily Check-Up Sheet
  - Attendance and Behavior
  - Number correct on Independent Practice
- Aim Check-Ups (bi-weekly)
  - Abbreviated version of the TEMI-PM
- Unit Check-Ups (bi-weekly)
  - 4 to 5 problems per skill
    - Ordering and Comparing Numbers
    - Relationships of Ten
    - Magnitude Comparisons
  - 2 problems for Word Problem Solving

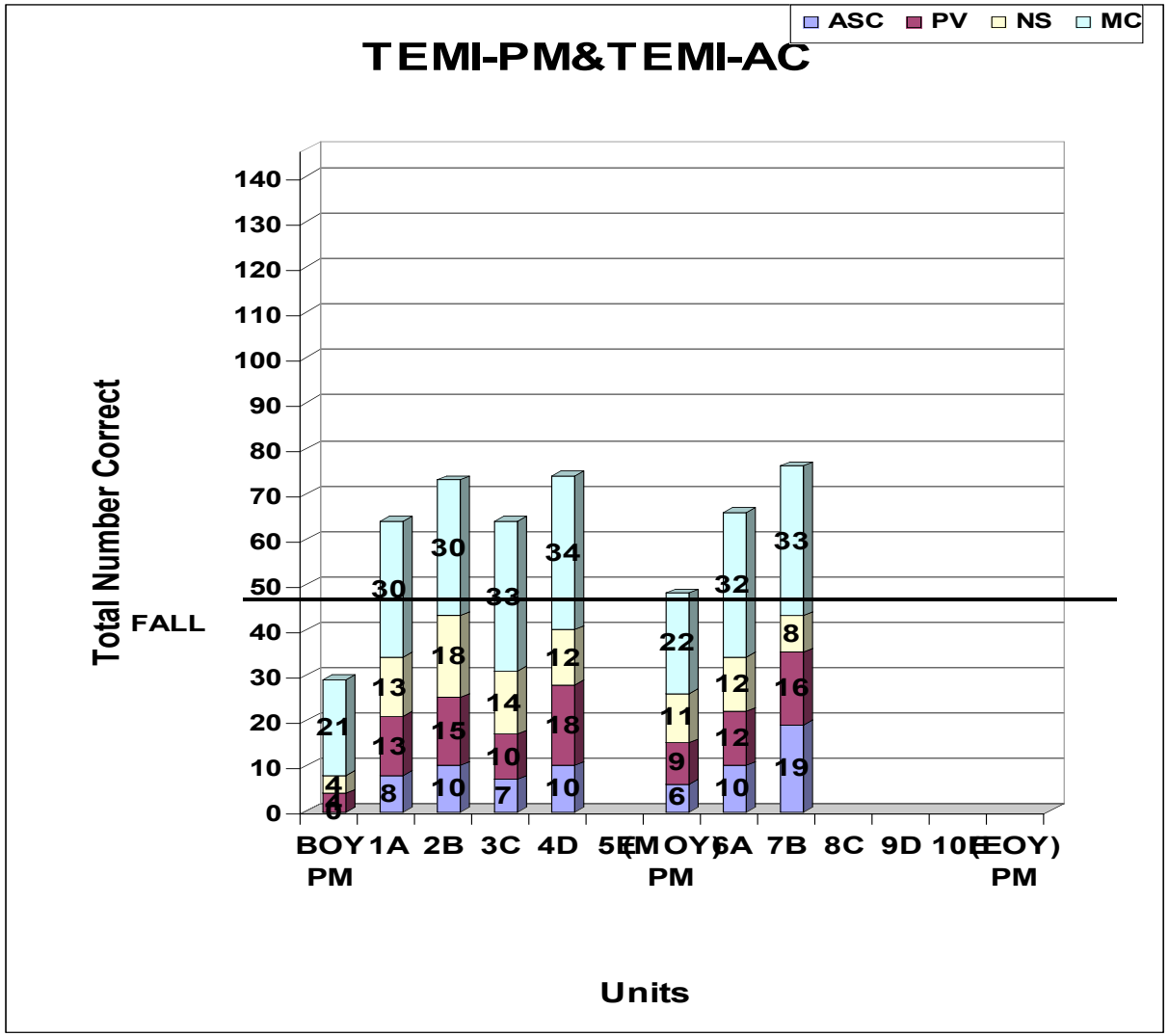
Daily Progress Monitoring Example

- Used to guide instruction, monitor struggling students, provide error correction, or assist in readjusting groups

1st Grade Unit 6									
Tutor: Diane									
School: Little Kids Elementary	**2/18**	**Lessons 1-3**			**2/19**	**Lessons 4-6**			
WEEK 1 Students	**Attendance**	**WPS**	**OCN (/5)**	**Behavior**	**Attendance**	**ASF (/10)**	**ROT (/6) (1st)**	**ROT (/10) (2nd)**	**Behavior**
Hughes, Kathleen			/5			/10	/6	/10	
Porterfield, Jennifer			/5			/10	/6	/10	

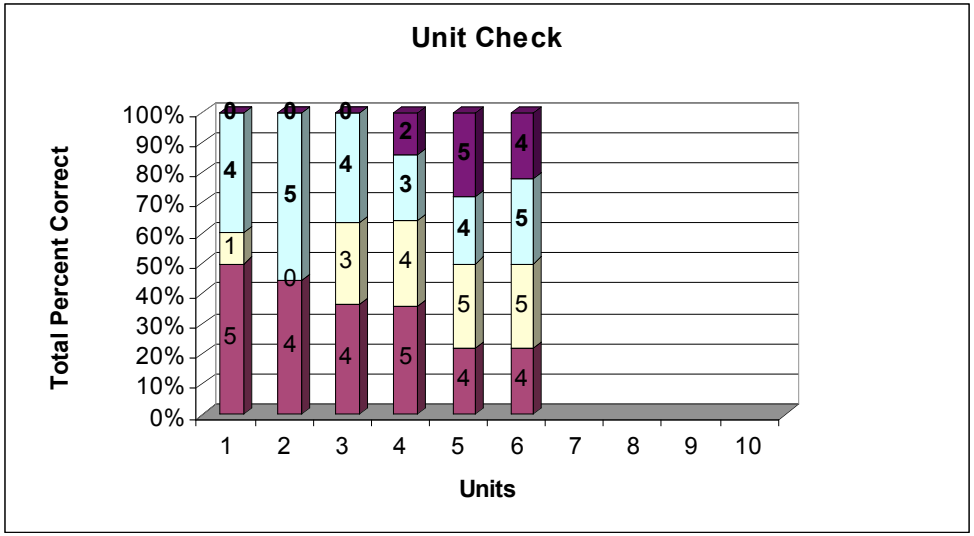
Graphing Progress Monitoring Data

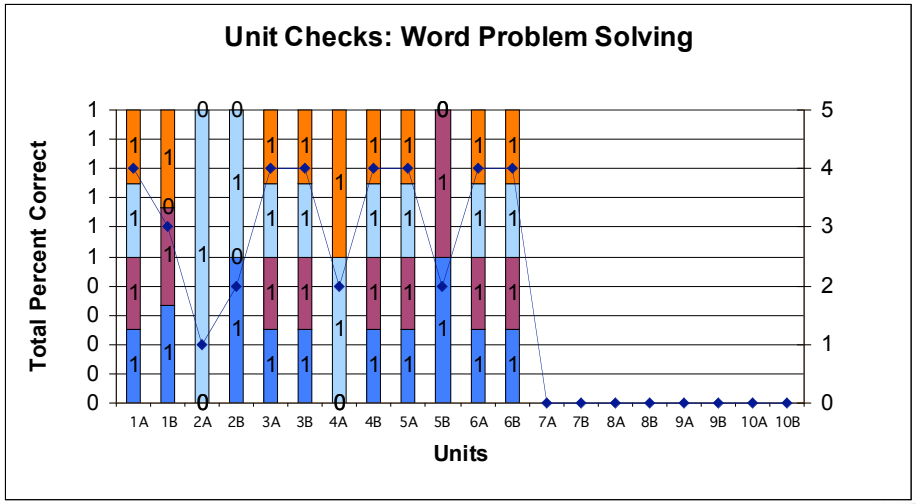
- Data collected on the Aim Check-Ups is graphed using Microsoft Excel



Graphing Progress Monitoring Data

- Data collected on the Unit Check-Ups is graphed using Microsoft Excel





What we know. . . . .

- Multiple opportunities to practice within the lessons
- Good pacing
- Error correction
- Opportunities to make, show, write number concepts; problem solving
- Regular, consistent intervention 4-5 days per week
- Strategies to procedural knowledge
- Progress Monitoring/Data

*Based on Research for Students with Difficulties/Disabilities

The Access Center

- http://www.k8accesscenter.org/training_resources/math.asp
  - **Mathematics Strategy Instruction (SI) for Middle School Students with Learning Disabilities**
  - **Using Mnemonic Instruction to Teach Math**
  - **Using Peer Tutoring for Math**
  - **Computer-Assisted Instruction and Math**
  - **Direct/Explicit Instruction and Math**
  - **Learning Strategies and Math**
  - **Concrete-Representational-Abstract Instructional Approach**
  - **Learner Accommodations and Instructional Modifications for Students with Learning Disabilities**

More Resources

- **Math Differentiation Brief**
- **Math Graphic Organizers**
- **Math Problem Solving for Primary Elementary Students with Disabilities**
- **Math Problem Solving for Upper Elementary Students with Disabilities**
- **Illuminations**http://illuminations.nctm.org/
- **MathTools**http://www.mathforum.org/mathtools/
- Meadows Center for Preventing Educational Risk: Mathematics Institute for Learning Disabilities and Difficulties
  http://www.meadowscenter.org/
- www.earlymathintervention.org

What Works Clearinghouse

- **WWC Evidence Standards:**
  - identify studies that provide the strongest evidence of effects
  - randomized controlled trials and regression discontinuity studies, and secondarily quasi-experimental studies of especially strong design
  - "Meets Evidence Standards"
  - "Meets Evidence Standards with Reservations"
  - "Does Not Meet Evidence Screens"

  http://ies.ed.gov/ncee/wwc/

  http://ies.ed.gov/ncee/wwc/reports/topic.aspx?tid=04 (reports)